Art. XXI.—*On "Surcharge" of the Bullion Assay.*

By Robert Barton, Esq.

[Read 6th September, 1875.]

It is generally understood by assayers that the surcharge of the gold cornet does not exactly represent the residue of silver which the parting has failed to boil out, and that it is on the contrary a resultant error, in fact the difference between this silver residue and the loss which the gold suffers by volatilization in the muffle and absorption by the cupel.

As these two opposite sources of error vary according to circumstances of temperature of the muffle, porosity of the cupel, thickness of the ribbon forming the cornet, quantity of lead and proportion of silver employed, strength of acid, time of the operations, &c., it becomes necessary to control the work by the use of "proof" assays of gold of known fineness, which, passed with the work under exactly the same conditions throughout, show what correction for "surcharge" is to be made in each case.

The more closely a routine is adhered to—the same from time to time in all its minor details of temperature, &c., using cupels of the same make, acid from the same bulk—the more uniform will the surcharge remain, from day to day. But even when this approximate uniformity is secured, there still remains an influencing cause, the neglect of which will lead to reports of a comparatively inaccurate character; *the loss on the cupel depends upon the quantity of gold in the assay*, so that the surcharge will be greater in samples of gold of high fineness, than in those of low gold, passed in the same fire and parted in the same acids.

The loss of gold may be so great as exactly to neutralize the excess weight due to silver left in the cornet, when a surcharge of 0 will result; or the volatility may exceed what is required for compensating the excess weight due to remanent silver, when the surcharge will be represented by a negative sign. Something must in such instances be added to the weight of the cornet, in order to represent the exact fineness of the sample assayed.

In practice, the variation of surcharge in agreement with the varying fineness of the samples may be compensated by passing in the same fire proofs of fine gold of weights

approximately corresponding to the presumed fineness of the several assay pieces under trial, correcting each of the latter by its corresponding proof; gold of ·9 by the 9 grains proof, gold of ·7 by the 7 grains proof, and so on (supposing the assay pound in these instances to be 10 grains). But with rough gold especially, of which often a large range of finenesses is passed in one fire, it would be exceedingly operose to provide proofs for each variation and for commercial, as distinguished from purely experimental work, some kind of general rule or compromise has to be made.

The following experimental trials illustrate the case :

Silver employed 2½ times the weight of the gold.
Lead ,, 84 grains.
All other conditions the same throughout.

According to the above results, when with full pound of fine gold, the surcharge equals + ·00085. Then,

With 8 grains under same influences the surcharge is reduced to one-half.
With 7 ,, ,, ,, ,, to one-quarter.
At 6 ,, ,, ,, ,, to zero.
At 2·5 the "minusage" is nearly equal in amount to the "plusage" at 10.

Of course by altering the weight of lead or in any other manner modifying the ruling conditions, other figures would be obtained, but special experiment under any given routine would show the interrelation existing between the surcharge quantities for the several finenesses of gold.

The attached graphic illustration shows the results of these experiments. The vertical column represents surcharge; the horizontal series of figures shows fineness or quantity of gold contained in the assay; the line *A* (———) connects the results of actual experiments; the line *B* (- - - - - - - - -) averages the results; and the straight line *C* (. . . . .) connects the extreme results.

When samples of gold of different finenesses are passed with proofs of the full pound of fine gold, with proportions of silver and lead, &c., as already stated; from the surcharge indicated by these proofs, that for any low gold may be approximately estimated by reference to the subjoined table deduced from lines ruled parallel to *C*.

Half these experiments were performed by Mr. Foord, and half by myself, so that personal error may be considered to be eliminated by the combination of results.

FOUND BY EXPERIMENT.

Fine Gold.	Surcharge.				
grains.	I.	II.	III.	IV.	Mean.
With 10	+ ·0008	+ ·0009 25	+ ·0008 661	+ ·0008 161	+ ·0008 518
„ 9	+ 5 571	+ 5 819			+ 5 695
„ 8	+ 4 25	+ 5	+ 3 229	+ 3 979	+ 4 114
„ 7	+ 7 5	+ 0 25	+ 1 637	+ 1 138	+ 2 631
„ 6	+ 0 5	+ 0 5	+ 0 047	− 0 703	+ 0 114
„ 5	− 2 5	+ 0 5	− 0 045	− 3 339	− 1 346
„ 4	− 4 25	− 1 5	− 6 135	− 5 635	− 4 38
„ 3	− 7 25	− 5	− 5 976	− 5 976	− 6 05
„ 2	− 12 5	− 9 5	− 10 317	− 10 067	− 10 596
„ 1	− 14	− 11 25	− 10 658	− 13 408	− 12 329

APPROXIMATE SURCHARGE TABLE.

1·0	·9	·8	·7	·6	·5	·4	·3	·2	·1
+ 14	+ 11½	+ 9½	+ 7	+ 5	+ 2½	+ 0	— 2	— 4½	— 7
+ 13	+ 10½	+ 8½	+ 6	+ 4	+ 1½	— 1	— 3	— 5½	— 8
+ 12	+ 9½	+ 7½	+ 5	+ 3	+ ½	— 2	— 4	— 6½	— 9
+ 11	+ 8½	+ 6½	+ 4	+ 2	— ½	— 3	— 5	— 7½	— 10
+ 10	+ 7½	+ 5½	+ 3	+ 1	— 1½	— 4	— 6	— 8½	— 11
+ 9	+ 6½	+ 4½	+ 2	+ 0	— 2½	— 5	— 7	— 9½	— 12
+ 8	+ 5½	+ 3½	+ 1	— 1	— 3½	— 6	— 8	— 10½	— 13
+ 7	+ 4½	+ 2½	+ 0	— 2	— 4½	— 7	— 9	— 11½	— 14
+ 6	+ 3½	+ 1½	— 1	— 3	— 5½	— 8	— 10	— 12½	— 15
+ 5	+ 2½	+ ½	— 2	— 4	— 6½	— 9	— 11	— 13½	— 16
+ 4	+ 1½	— ½	— 3	— 5	— 7½	— 10	— 12	— 14½	— 17
+ 3	+ ½	— 1½	— 4	— 6	— 8½	— 11	— 13	— 15½	— 18
+ 2	— ½	— 2½	— 5	— 7	— 9½	— 12	— 14	— 16½	— 19
+ 1	— 1½	— 3½	— 6	— 8	— 10½	— 13	— 15	— 17½	— 20
+ 0	— 2½	— 4½	— 7	— 9	— 11½	— 14	— 16	— 18½	— 21
— 1	— 3½	— 5½	— 8	— 10	— 12½	— 15	— 17	— 19½	— 22
— 2	— 4½	— 6½	— 9	— 11	— 13½	— 16	— 18	— 20½	— 23
— 3	— 5½	— 7½	— 10	— 12	— 14½	— 17	— 19	— 21½	— 24
— 4	— 6½	— 8½	— 11	— 13	— 15½	— 18	— 20	— 22½	— 25
— 5	— 7½	— 9½	— 12	— 14	— 16½	— 19	— 21	— 23½	— 26
1·0	·9	·8	·7	·6	·5	·4	·3	·2	·1

The figures in the columns denote ten-thousandths of unity.